CLAIMS

[Claim(s)]

[Claim 1] it is the method of cleaning the internal surface of a plasma polymerization chamber -- a -- [it is equal or / gas / more / at least one / in volume / fluoride content] The inorganic halogen content plasma reactant gas which is equal, or takes and contains an etchant gas mixture with little at least one chlorine content gas in volume is introduced to a plasma polymerization chamber, b) Excite a reactant gas mixture under the environment which does not have an atom-like oxygen content kind in operation, and form plasma, And a method equipped with contacting the internal surface of c chamber to the volatile reacting species of plasma, and at least a part of organicity and metallicity process residual substance secondary output being volatilization-ized, and removing from the effluence-of-gas oral region of a chamber.

[Claim 2] The method which is a method according to claim 1 and is characterized by contact of said residual substance contacting said plasma directly.

[Claim 3] The group which it is a method according to claim 1, and said fluoride content gas becomes from SF6, NF3, ClF3, CF4, CHF3, and C4F8, and the group which it is characterized by being chosen out of the mixture, and said chlorine content gas becomes from Cl2, HCl, BCl3, CCl4, and SiCl4 and its mixture from -- method characterized by being chosen.

[Claim 4] The method which is a method according to claim 3 and is characterized by choosing said fluoride content gas from the group of the inorganic gas which consists of SF6, NF3, and ClF3, and its mixture substantially.

[Claim 5] The method characterized by being a method according to claim 3 and said fluoride content gas being the quantity of about 50 to 90 at the volume percent of all the gas mixture things.

[Claim 6] The method characterized by being a method according to claim 5 and said fluoride content gas being about 52 to 88% of quantity at the volume percent of all the gas mixture

things.

[Claim 7] The method characterized by being a method according to claim 3 and said inorganic halogen content gas mixture thing being SF6/Cl2.

[Claim 8] Within giving the plasma process unit which is the method of the plasma process for the residual substance removal continued in the plasma process of work piece, and consists of an a chamber and a pair of electrodes each other turned conversely, and b chamber Sufficient electric energy for one electrode to hold semiconductor work piece and generate plasma glow discharge conditions is supplied, c) [introducing to a chamber the reactant gas in which plasma production is possible under the electric energy conditions supplied to an electrode, and d work piece / in the place which etching secondary output occurs and adheres to the internal wall of a chamber as a pollution residual substance sediment] Carrying out a plasma process and e work piece are taken out from a chamber. and f (I) -- [it is equal or / gas / more / in volume / large / of quantity / at least one / fluoride content] It is equal or [or a plasma reactivity etchant gas mixture with at least one chlorine content gas of a more / in volume / small quantity] Introduce into the interior space of a chamber, generate the plasma of (II) reactivity halogen gas mixture thing under the environment which does not have an oxygen kind substantially, contact said plasma to the accumulated pollution sediment which has adhered to the internal surface of a chamber further (III), and plasma changes a residual substance into gas ****. How to consist of removing from a chamber.

[Claim 9] The group which it is a method according to claim 8, and said fluoride content gas becomes from SF6, NF3, ClF3, CF4, CHF3, and C4F8, and the group which it is characterized by being chosen out of the mixture, and said chlorine content gas becomes from Cl2, HCl, BCl3, CCl4, and SiCl4 and its mixture from -- method characterized by being chosen.

[Claim 10] The method which is a method according to claim 9 and is characterized by choosing said fluoride content gas from the group of the inorganic gas which consists of SF6, NF3, and ClF3, and its mixture substantially.

[Claim 11] The method characterized by being a method according to claim 8 and said fluoride content gas being the quantity of about 50 to 90 at the volume percent of all the gas mixture things.

[Claim 12] The method characterized by being a method according to claim 11 and said fluoride content gas being about 52 to 88% of quantity at the volume percent of all the gas mixture things.

[Claim 13] The method characterized by being a method according to claim 9 and said inorganic halogen content gas mixture thing being SF6/Cl2.

[Claim 14] A means to introduce a metal chamber, the source of plasma generating gas, and said gas into said etching chamber, And the work piece which has the electromagnetic energy source electrically combined with the electrode in said chamber for generating plasma within

said chamber is set to the plasma equipment which carries out a process. It is equal or Or more at least one fluoride content gas in volume, Equipment characterized by having a means to control the introduction to the plasma environment which does not have oxygen substantially in the plasma generating etchant gas mixture which is equal or consists of an etchant gas with at least one less chlorine content gas in volume.

[Claim 15] The group which it is equipment according to claim 14, and said fluoride content gas becomes from SF6, NF3, ClF3, CF4, CHF3, and C4F8, and the group which it is characterized by being chosen out of the mixture, and said chlorine content gas becomes from Cl2, HCl, BCl3, CCl4, and SiCl4 and its mixture from -- equipment characterized by being chosen.

[Claim 16] Equipment which is equipment according to claim 14 and is characterized by choosing said fluoride content gas from the group of the inorganic gas which consists of SF6, NF3, and ClF3, and its mixture substantially.

[Claim 17] Equipment characterized by being equipment according to claim 14 and said fluoride content gas being the quantity of about 50 to 90 at the volume percent of all the gas mixture things.

[Claim 18] Equipment characterized by being equipment according to claim 17 and said fluoride content gas being about 52 to 88% of quantity at the volume percent of all the gas mixture things.

[Claim 19] Equipment characterized by being equipment according to claim 14, and combining said electromagnetic energy source with said plasma equipment inductively, and introducing fluoride content gas by about 150 sccm(s) from the flow velocity 90, and introducing chlorine content gas by about 20 sccm(s) from the flow velocity 80 [about] simultaneously.

[Claim 20] Equipment characterized by being equipment according to claim 14, and combining said electromagnetic energy source with said plasma equipment inductively, and introducing fluoride content gas by about 50 sccm(s) from the flow velocity 30, and introducing chlorine content gas by about 20 sccm(s) from the flow velocity 140 [about] simultaneously.

[Claim 21] Equipment characterized by being equipment according to claim 16 and said inorganic halogen content gas mixture thing being SF6/Cl2.

[Claim 22] It is the method of the residual substance control plasma process of the work piece within the plasma reaction apparatus which includes execution for dry-cleaning etching on the surface of internal of a reaction chamber. the plasma process of semiconductor work piece while said etching is advancing -- on the way -- come out and it is -- and (a) -- [it is equal or / gas / more / at least one / in volume / fluoride content] The halogen content reactivity gas mixture thing which is equal or consists of an etchant gas with at least one less chlorine content gas in volume is introduced to a vacuum plasma process chamber, (b) Generate the plasma of a reactant halogen gas mixture thing under the environment which does not have an oxygen kind substantially, Furthermore, the method characterized by contacting said plasma to

the accumulated pollution sediment adhering to the internal surface of the (c) chamber, and for plasma changing a residual substance into gas ****, and removing from a chamber.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the method and equipment which were accumulated on the internal surface of a vacuum processing chamber and from which it precedes and the deposited parasitic contaminant residual substance is removed. In detail, this invention relates to the plasma equipment and the dry cleaning clean etching process of offering a certain kind of halogenation washing-ized gas, in order to remove a semiconductor residual substance accumulation thing on the internal parts of a plasma process chamber, and the surface.

[0002]

[The technical problem which a Prior art and invention make solution ******] The homogeneity of a marginal size and the maintenance possibility of accuracy are severer as the geometric size of a semiconductor device becomes smaller. Many of processes performed with a semiconductor process reaction apparatus make contaminant deposition remain on a process chamber wall, and they serve as a source of the particle substance which becomes harmful when ****(ing) and manufacturing a semiconductor device. It is an important target by more than former to lose the pollution particle substance on the surface of semiconductor work piece as the size size of semiconductor board structure becomes smaller. The particle-like pollution sediment accumulated on the semiconductor process chamber wall is important especially when a metal etching process is carried out within a chamber. Especially etching of an aluminum pattern brings about such a lot of accumulation relatively. Generally this aluminum film is etched using the reactant gas of what kind which contains halogen and halogenation carbon gas as a plasma ingredient. [the etchant gas used] in more detail Mainly it is chlorine content gas of chlorine (Cl2) and boron trichloride (BCl3), these will enable formation of a volatile aluminium chloride compound at the time of etching, and volatile matter will be removed from an etching process by using a vacuum. With a volatile aluminium chloride compound, however, other activity chlorine, And a boron content kind is formed, the oxygen which exists in an etching process chamber and water or the organic matter kind from a patternizing photoresist, and a reaction are possible for this, and, as a result, it forms a non-volatile pollution sediment on the internal wall of a process chamber, and the internal surface. The thickness of this pollution sediment increases according to time progress, and from the surface, the adhering sediment separates simply, falls, breaks small, as a result, falls and adheres on work piece, causes contamination, and serves as a defect of wafer work piece. In

order to avoid serious defective generating of the wafer under these conditions, the chamber must carry out an operation stop and must carry out the main washing.

[0003] The plasma chamber sanctification method known opens a plasma etching chamber, removes the portion of a chamber, and removes a pollution sediment by the physical variance or the chemical method. For example, a chamber is whether to wash by hand using the solvent which rinses with the solution of water and isopropyl alcohol, or dissolves various contaminants. an etching chamber -- or it washes with water, and wipes in alcohol, and it is possible to also make it dry. All these "wet (wet)" sanctification methods are complicated, it is destructive, time is required, and this also serves as further pollution source again. Furthermore, in the case of a plasma reaction apparatus with the large-sized main sanctification process, production lost time becomes in 24 hours, and the obstacle on production by this sanctification is attached very at an expensive price.

[0004] A plasma excitation dry cleaning process exists and it is removed from that of the adhering contaminant carrying out plasma etching to the internal wall of a metal etching reaction chamber using a carbon tetrachloride and oxygen. However, the plasma excitation dry cleaning system known now becomes equal to 10% from about 5% of the time which needs a dry-cleaning time interval for the metal etching process itself.

[0005] [furthermore, the chamber dry-cleaning process of the conventional technology] While using PURAZU my etching halogenation gas like Cl2, CCl4, HCl, CF4, and C2F6, generally an oxidizer like oxygen or hydrogen peroxide is used, and these oxygenation thing certainly has a fault. For example, it is found out that metal etching dry cleaning prescription containing a halogenation compound, and oxygen or oxygen content gas is dissatisfied. It is because the suboutput of aluminum acid halide with the powdered Reason is formed and these are work piece contaminants equal to what should be removed from the first.

[0006] [a U.S. Pat. No. 5,356,477 Description (October 18, 1994, such as Chen)] The mixture of chlorine content gas and an oxygen content oxidizer is introduced into a plasma process chamber, and the organicity on the internal surface of a chamber and the single step plasma sanctification method of being activated so that metal content residual substance plasma picking may remove are indicated in cleaning gas plasma. This patent also teaches that fluorination gas still like CF4 as a sanctification gas mixture thing can be added. While this cleaning gas prescription and process remove a residual substance from the internal surface of a plasma chamber efficiently, [use of oxygen content gas] It is the required portion of a patent dry-cleaning prescription, it is the aluminum acid fluoride which is not desirable, and since the suboutput slack solid-like powder contaminant of this sanctification technology forms, there is essentially a problem.

[0007] [United States patent 4th and a No. 786 or 359 Description (January 25, 1994, such as Gabric)] A fluoridation carbon thing like C2F6 or CF4 in which a plasma cleaning process and

equipment are indicated, Etching gas prescription like ozone / oxygen mixture is activated within a vacuum chamber on excitation frequency in RF field, and chamber cleaning is efficiently carried out with a high etching rate. It is shown that a patent teaches that use of halogenation carbon etching gas brings about polymer film deposition in a plasma reaction apparatus, and such a formation thing serves as a negative factor in use of such gas. That oxygen / ozone mixture adds controls such polymer formation, therefore it is the indispensable ingredient of patent etching gas. Furthermore, in dry-cleaning prescription of the conventional technology referred to in the top, this etching gas mixture generates a solid parasitic aluminum fluoride secondary output like aluminum acid fluoride, for example.

[0008] All the dry clean conventional technology referred to has described plasma activation of the clean etching gas mixture containing halogen and/or halogenation carbon gas, and an oxidizer. [these cleaning gas prescription and processes] while removing the internal pollution residual substance in a chamber efficiently, since the oxygen content gas which generates the non-volatile aluminum acid halide which is work piece contamination with a wafer plasma process system is used, the technology will essentially become restrictive -- further Aluminum acid halide like aluminum acid fluoride is solid powdered form, and blocks the small orifice in a process chamber like the hole of a gas supply plate. So, in halogen GASUDORAI clean etching, any use of an oxygenation kind generates the powdered aluminum acid halide which is the output which similarly weakens the wafer contamination and the process which are not desirable.

[0009] The pollution deposition on a plasma process chamber wall can be removed by the ion bombardment or chemical reaction in the inside of plasma. Since the plasma chamber wall is usually grounded electrically, the chemical reaction of the ion bombardment (the weld slag rig effect) of the chamber wall itself is not effective generally and desirable for cleaning the chamber surface. The most desirable method of removing a pollution sediment using a chemical reaction is changing the sediment into a volatile kind so that it may remove from a plasma process chamber with a ******** pump. So, it is the method of a dry-cleaning plasma process chamber (especially metal etching chamber). The pollution sediment of the process chamber surface is changed into the volatile kind simply removed from a process chamber, and the suboutput which is not desirable is not generated any more. It will be desirable to offer a method.

[0010] Probably it is the efficient plasma chamber dry-cleaning method, and an on-going wafer etching process will be that it is still more desirable independently to have the method of supposing a part and operating it. The obstacle will not carry out wafer handling process capability so much, and such intermittent cleaning technology will prevent accumulation of the pollution etching secondary output of the shape of KUREKU on the internal surface of a plasma chamber. [such an advantageous point as it is (inch situ) as the whole sanctification

technology] It is the quality control by which the wafer (contamination which becomes empty, and which is not, or work piece which becomes empty from that of a defect, and which is not) by which the process is carried out has been improved, and is reducing an operation stop of a required plasma chamber in the usual wet cleaning. In a large-sized chamber, it becomes trap ****** comparatively like cost of the vacuum chamber of 24 hours by such operation stop.
[therefore, this invention used as manufacture Ross of the work piece by which the process was carried out] It is based on discovery of an exact dry-cleaning chemical-species prescription used in the plasma environment which does not have atom-like oxygen for removal of the parasitic residual substance already deposited on the internal surface of a vacuum plasma process chamber, and a member. It was found out that the gas mixture thing of chlorine and fluoride containing inorganic gas is effective in the internal member of a plasma polymerization chamber and surface plasma dry cleaning. Although the mechanism of sanctification is not known well, an inorganic gas prescription of this invention contains fluoride content gas like NF3, and, probably will be considered to react with an organic matter residual substance under the plasma conditions which remove a carbon substance. All the reactions with one possibility are given by the following formula.
[0011] 4NF3 + 3C ------ > 3CF4 + Probably, 2N2 chlorine content gas reacts with a metal contaminant residual substance, and it is [the gas-like metal chloride AlClx and] AlCl3 that it may be most. It is thought that it generates.
[0012]
[Effect of the Invention] This invention cleans and controls accumulation of the pollution plasma process secondary output accumulated in the internal surface of the semiconductor process chamber, and the method of so decreasing greatly the stop time of equipment required for the main sanctification of a chamber is offered. This invention extends the interval of wet sanctification of a required chamber by offering a single plasma activity dry-cleaning step using the mixture of the chlorine and fluoride content gas by which oxygen or an atom-like oxygen content kind does not exist of a certain kind. this single cleaning step -- (a) -- [it is equal or / gas / more / of quantity / fluoride content] The halogen content plasma reactant gas mixture which is equal or consists of chlorine content gas of a smaller quantity is introduced into the vacuum plasma process chamber which does not include an atom-like oxygen content kind substantially, (b) [generating the plasma of said reactant gas and the (c) aforementioned plasma, and/or the generated kind] Plasma gas reacts with an organic residual substance and a metal residual substance alternatively, and it has making the accumulated residual substance adhering to the internal surface of the chamber which the type of gas removed from a chamber through the exit port of a chamber is made to volatilization-ize contact.
[0013] It is the mixture with halogen content plasma reactant gas serving as plasma activity nothing as what distinguishes this invention from others in existence of oxygen, and plasma's,

contacting the inside surface of Chamba as a result, and volatilization-izing a surface adhesion residual substance efficiently and effectively from a chamber. As the on-going plasma process of a semiconductor, and an independent process, the sanctification technology of this invention may be used as a subfollowing process. Thus, an operation stop interval required for the main wet sanctification of a chamber serves as the smaller number of times, and, thereby, improves the cost efficiency of the whole plasma process of a semiconductor.

[0014] When plasma etching of aluminum is carried out within a plasma process chamber, some non-evaporativity pollution sediments [at least] found out by the chamber wall are the polymer form of AlxCly. x and y are the about 1 to about 5 number of between here.

[0015] Generally these non-evaporativity pollution sediments are formed of existence of various elements like carbon, boron, nitrogen, and hydrogen within an etching chamber between plasma etching. Plasma dry cleaning of the reaction chamber which uses the inorganic halogen gas mixture thing of this invention under the environment which does not have oxygen substantially makes aim **** of these contaminant groups possible, and makes it possible volatilization-ization and to remove quickly from a chamber.

[0016] Furthermore, dry-cleaning prescription of this invention does not form solid pollution secondary output like other metal acid halide which is not desirable. This metal acid halide is usually expected in etching dry cleaning of the chamber polluted with Accumulation AlxCly.

[0017] it preceded with this invention, and it was usually easy to boil using fluoride gas like NF3, SF6 or F2, and CF4C4F8 in combination with oxygen O2, it was known, and it was in ** M which removes the accumulated organic residual substance, and was effective in dry etching sanctification. However, these plasma reactant gas generates the aluminum (AlxOyFz) which is pollution secondary output. Generally formation of the aluminum acid fluorination thing was considered not to be avoided. It is because oxygen exists in sanctification prescription in fact. [etching dry clean gas prescription of this invention] It is equal, or is equal to more plasma reaction inorganic matter fluoride gas of the amount of volume, or anticipation that the suboutput which is not desirable forms is smashed by using the mixture of the less mineral salt ghost gas of the amount of volume in the plasma environment which does not have an oxygen kind substantially.

[0018] This invention is the method of cleaning a plasma process unit and its internal surface, and offers the thing using halogen etching gas mixture prescription of this invention under the plasma environment which does not have atom-like oxygen substantially. Furthermore, the method of the plasma etching of semiconductor work piece including using the etching dry-cleaning technology of this invention as a subfollowing process is offered. The effect and efficiency of an inorganic halogen gas mixture thing of this invention make it usable as a step intermittent or as it is in an on-going plasma etching process. The advantageous point of such application includes removing a pollution residual substance continuously from the internal

surface of a chamber, without [without it carries out the ********** chamber operation stop for the main wet sanctification, therefore] spoiling wafer throughput. Furthermore, the cleaning technology of this invention is boiled always and may be used by frequency un-destructive again so that it may avoid accumulation of the shape of flakes which becomes inevitable to the particulate contaminant which floats in a plasma etching process.

[0019] a whose method of this invention is what has the following step -- [it is equal or / gas / more / in volume / fluoride content] The step which is equal, or takes and introduces the gas mixture thing of little chlorine content gas in volume to a plasma process chamber, b) The step which forms plasma under the environment which activates a plasma reactant gas mixture and does not have an atom-like oxygen content kind in operation, And the step which the volatile reacting species of plasma are made to contact, and a part of accumulated solid-state-plasma PUROSEZU residual substance [at least] is volatilization-ized, and removes the internal surface of c chamber from a chamber.

[0020] Further, this invention relates to the method of the residual substance control plasma process of work piece, give it, and the plasma process unit which consists of an a chamber and a pair of electrodes each other turned conversely within b chamber One electrode holds semiconductor work piece and supplies sufficient electric energy to generate plasma electric discharge conditions. c) [in the place which the reactant gas in which plasma production is possible is passed to a chamber under the electric energy conditions currently supplied to the electrode, and d solid residual substance is generated, and adheres to the internal wall of a chamber as a pollution sediment] Carry out the plasma process of the work piece, and e work piece is taken out from a chamber. further -- f -- the following 1 -- [it is equal or / gas / more / in volume / large / of quantity / fluoride content] It introduces into the interior space of the chamber which is equal or does not have an atom-like oxygen kind substantially in more [in volume] few reactant halogen gas mixture things of the mineral salt matter content gas of quantity. 2) Generate the plasma of a reactant halogen gas mixture thing, and contact the accumulated pollution sediment adhering to the internal surface of further 3 chamber to the plasma (and/or, reacting species), and plasma changes a residual substance into gas ****, and removes from a chamber. It is related with the method of having the dry-cleaning step which consists of things.

[0021] This invention Moreover, a means to introduce such a substance to the metal chamber which carries out the process of the work piece, and a plasma generating substance and said etching chamber, Are improvement of plasma equipment which is electrically combined with the electrode in said chamber for generating plasma, and has an electromagnetic energy source, and [the improvement] It is equal, or is equal to the more [in volume] large fluoride content gas of quantity, or the adjustment device of the introduction to the plasma environment which does not have an atom-like oxygen kind substantially in the plasma generating gas

which consists of a reactant halogen gas mixture thing of the mineral salt matter content gas of a more [in volume] small quantity is included.

[0022]

[Mode for carrying out the invention] In the plasma process method of this invention, the mixture of a certain halogen etching gas is used as prescription which carries out dry cleaning of the internal surface of a plasma process unit. Application to dry cleaning of the gas mixture thing of this invention is carried out under the plasma environment which does not have an oxygen kind substantially. One of the gas mixture thing of this is fluoride content gas like SF6NF3, ClF, CF4, CHF3, and C4F8.

[0023] Other gas is inorganic chlorine content gas like Cl2, HCl, BCl3, CCl4, and SiCl4. The halogenation sanctification gas mixture thing of this invention is equal, or equal to the more [in volume] large fluoride content gas of quantity, or in order to validate the desirable mixture containing the chlorine content gas of a more [in volume] small quantity, it is supplied to a chamber with another degree of gas flow rate. Preferably, fluoride content gas is included, it is more desirable and a halogen gas mixture thing has more the great portion of volume by the volume of a gas mixture thing than 50% (however, 90% is not exceeded). The joint effect by the reactant gas mixture operated in the plasma environment which does not have an atom-like oxygen kind substantially makes possible effective dry cleaning on the surface of internal of a plasma process chamber.

[0024] This invention relates to the method and equipment for pollution particle removal from the internal surface of a plasma reaction chamber further by plasma dry cleaning by the halogen gas mixture thing of this invention. This invention is useful for especially removing the parasitic pollution volume thing generated in the plasma etching of metal work piece. This process is explained in the following desirable working example by the word "evaporation" of the organic metal substance and compound containing the organic metal sediment generated in a metal etching process, especially aluminum. However, it is a plasma etching system about the inorganic halogen gas mixture thing of this invention, plasma generating secondary output is volatilized, and, generally the idea of using it for the purpose removed from a plasma chamber wall can be applied to a semiconductor process chamber.

[0025] Fluoride content gas like SF6 used by dry cleaning of an etching chamber should serve as the range of about 50 to 90 volume % of the whole quantity of the halogenation etching gas mixture of this invention used. Therefore, chlorine content gas should become 50 volume % from about 10. The quantity of fluoride content gas is the range of about 52% to 88 volume % preferably. When it is made such, [for example, the etchant gas mixture of this invention] To a 9l. etching chamber, when passing by the flow velocity of about 60 sccm(s) from about 20 standard cube SENCHIMETA per minute (sccm), the flow velocity of fluoride content gas serves as about 10 (50 volume [of 20sccm] %) to about 54 sccm(s) (90 volume [of 60sccm]

%). When a more large-sized or small etching chamber is used, the flow velocity is adjusted in an increase or the reduction direction, respectively, but similarly the ratio of fluoride content gas is held to the whole quantity of the dry etchant gas mixture used in a process.

[0026] The whole quantity of the etchant gas passed to the etching chamber for the dry-cleaning etching process of this invention is dependent on the size of a chamber, and the size of a wafer a little. usually, [chamber / about 13l. / like AppliedMaterials Precsion 5000 MERIE Etch System which is a capacitive coupling plasma etching system / etching] It is suitable that it is between about 20 sccm(s) and about 500 sccm(s), and all the gas streams are held preferably at about 200 or less sccm. Probably, about other etching chambers like a guidance joint plasma etching reaction apparatus, adjustment is [gas flow rate] needed.

[0027] A dry cleaning clean process may be carried out under the plasma glow discharge process conditions usual [for attaining the suitable concentration of activated species] in order to volatilize the inorganic and organic parasitic sediment deposited on the plasma chamber wall. Therefore a required thing is fluoride content gas is more nearly equal than chlorine content gas in volume, or more, fluoride content gas is introduced at a bigger speed than chlorine content gas to a chamber. The mixture which it will not serve as effective dry cleaning if this gas stream difference has much especially important chlorine content gas, but exceeds 90% by the volume of fluoride content gas is a contaminant which is not desirable, and brings about formation of the powdered aluminum fluoride kind AlxFz. In the dry-cleaning etching process which uses a capacitive coupling etch apparatus, the gas flow rate of the one side chlorine content gas whose gas flow rate of fluoride content gas is generally the range of 30sccm to 50sccm is the range of 140 to 20sccm. In the dry-cleaning etching process which uses a guidance joint etch apparatus, the gas flow rate of the one side chlorine content gas whose gas flow rate of fluoride content gas is generally the range of 90sccm to 150sccm is the range of 80 to 20sccm.

[0028] (a) The process variable of ingredient [of a gas mixture thing] and flow velocity, (b) chamber pressure, (c) chamber wall temperature, (d) work piece PEDISUTARU temperature, and (e) supply RF electric power level ** may be chosen in order to attain the optimal plasma dry cleaning. Although shown in the top, carbon content gas is operational in the plasma pollution removal process of this invention, however it should be understood that such organic gas is a thing which it is under a plasma electric discharge condition and which carries out a grade polymerization. The deposition by such polymer generation and the shape of a subsequent inside of Chamba is an opposite effect in etching dry-cleaning use of an inorganic halogen gas prescription of this invention. For this Reason, inorganic fluoride content gas is desirable in practice in this invention. The organic fluoride content etchant gas is effective, and he carries out it in an operational thing end in operation of this invention, it is understood, and is R ****.

[0029] The fluoride content gas of this invention within the limits contains SF6, NF6, CF4, CHF3, C4F8, and the mixture of those. Desirable fluoride content gas is the thing of the inorganic substance of the gas containing SF6 and NF3. As for the chlorine content gas of **, Cl2, HCl, BCl3, CCl4, SiCl4, and those mixtures are contained as the 2nd ingredient of a mixture.

[0030] As for the usual plasma auxiliary aluminum etching, the process gas mixture of N2 is used as BCl3, Cl2, and an option. The aluminum between the aluminum etching processes using chlorine and on a substrate reacts with a chlorine atom, reacts with a chlorine content molecule as a possibility, and forms a volatile aluminium chloride kind. some of this etching secondary output is removed from a chamber by the pump -- [those some] on the other hand or [reacting with the organic kind from the photoresist for patterns which are other reacting species in a process chamber] -- or it adds, a non-volatile substance is given and the many are loosely deposited as contamination strong on the process chamber wall surface.

[0031] The plasma etching dry-cleaning process of invention using the halogen gas mixture thing of this invention is usable in combination with the conventional capacity electric discharge (parallel board) plasma generator, or combination with an inductively-coupled-plasma generator. the plasma accompanying the etching chamber between the etching processes of this invention is ******** about the plasma generated within the etching chamber, or the plasma generated toward the etching chamber itself, and reacting species flow and get down from the source of plasma toward a chamber.

[0032] Drawing 1 is what shows the parallel board etch apparatus 100 containing the conventional closed-down type metal plasma etching chamber 110. It has the chamber housing 114 which usually has the combination 115 to the exhaust air vacuum pump for the partial vacuum of the top lid 112, the side wall 122 made from aluminum, and the interior space of a chamber (not shown). The dry-cleaning gas of etchant and this invention goes into a chamber 110 through the gas supply plate 116 with which gas is supplied through an inflow system with a valve. The cathode on which, as for equipment, this acts as work piece maintenance PEDISUTARU 120 further including the source 117 of RF electric power supply, as for this equipment, It operates in combination with the chamber wall 122, the chamber housing 114, the chamber lid 112, and the gas supply plate 116 that acts as grounding anodes. The work piece 121 is held on PEDISUTARU 120, and this is shielded and (not shown) isolated from the grounding anode chamber wall 122. The plasma etching system is constituted so that reactant gas plasma may usually gather in the general field 118 of the work piece 121, and gas may be drawn between the gas supply plate 116 and PEDISUTARU 120. However, it is possible by removing the process wafer 121 and introducing gas prescription of this invention to carry out dry etching cleaning of the accumulation contaminant formed in the on-going wafer work piece 121 etching process from the internal surface.

[0033] In drawing 1 , when plasma supplies RF power supply to PEDISUTARU 120 in the field 118 of the plasma chamber 110, it generates. It depends for the external boundary of the plasma field 118 on the operation parameter of the etching chamber 100. Etching gas is left through a pipe 115 from the plasma chamber 110 according to the vacuum (not shown) supplied. The temperature of the substrate work piece 121 is leading the heat transfer inactive gas between the work piece 121 and the internal gap 129 of the maintenance platform 120, and control between processes is possible for it. In order to maintain the temperature of the maintenance platform 120, cooling water circulates through the cathode with which the maintenance platform 120 is attached. Water passes along a pipe 130 and comes out through a pipe 131. The electric power supply 117 to cathode PEDISUTARU 120 (namely, maintenance platform) A chamber wall, Since an electric field required to **** or ionize the gas held at the etching chamber 110 is generated, bias is applied to the chamber housing 114, the chamber lid 112, and the grounded anode that has the gas supply plate 116. In the process design of drawing 1 , the operational etching process and the plasma film deposition parameter are as follows. Etching chamber process pressure is below 700mm Thor, and is the range of about 10 to about 500mm Thor preferably. In order that etching chamber side wall (internal surface) temperature may float and may move a pollution particle from work piece, generally it is lower than work piece temperature at least 5 degrees C. Work piece temperature turns into operation temperature of a chamber, and the range of it is about 50 to 100 degrees C. The source of RF electric power currently supplied to the chamber is 800W from about 300.
[0034] The following example shows the effect of the inorganic halogen gas of this invention as pollution cleaning gas prescription which removes a residual substance from the internal surface of a plasma chamber in operation of this invention.
[0035]
[A working example 1] This working example offers the kind of general composition of the pollution adhesion thing formed on the surface of a metal etching processing chamber, when the work piece etched is the silicon wafer covered with the aluminum layer. In addition, the patternizing photoresist which consists of phenol formaldehyde NOBORAKKU resin should be further covered with the feeling agent of JIAZO quinone increase by the aluminum layer on a silicon wafer. Etching plasma was formed from the gas of BCl3, Cl2, and N2, and was passed by about 50 sccm(s), respectively. Electric power impressed was made into the range of W [about 500 to 800], the range of about 200 to 600 mtorr and the operation negative pole temperature of the pressure of the process chamber were about 80 degrees C, and the temperature of the chamber wall was about 45 degrees C simultaneously. Evaluation was performed after the wafer of 25-30 was etched. In order to evaluate the contaminant accumulated in the surface of the plasma chamber 110 of drawing 1 , extra jacket **** from the chamber wall 122 was taken out and analyzed. The data from this analysis About (in atomic

percent unit of the detected element) 10% - about 30% of aluminum, Existence of the element of the small quantity of about 2% - 4% of silicon, about 1% - 4% of boron, about 8% - 20% of chlorine, about 7% - 40% of carbon, about 3% - 40% of nitrogen, about 20% - about 40% of oxygen, and others or microscopic quantity was accepted. It is thought that a part of measured oxygen is depended on the oxygen which touched the surface of the accumulated pollution adhesion thing at the time of opening of a process chamber.

[0036] The atomic percent about a typical pollution adhesion thing and binding energy which were extracted from the chamber wall 122 are shown in the next table 1.

[0037]

[Table 1]

高分解能ＥＳＣＡデータ：結合エネルギー、原子百分率及びピーク帰属
（結合エネルギーは２８４．６ｍＶでの-$(CH_2)_n$-信号の結合エネルギーに対応
原子百分率は高分解能データから算出
ピーク帰属は基準化合物の結合エネルギーに基づく）

サンプルの種類	Al_1	Si_1	B_1	Cl_1	Cl_2	$^*Cl_3$	C_1	C_2	C_3	N_1	N_2	N_3	O_1	O_2	F_1
パターン化ウェハを６０℃でエッチング、その後、チャンバ壁から汚染付着物を削り取った															
結合エネルギー(eV)	75	－	192	－	198	201	285	286	288	399	400	－	531	533	639
原子百分率	7	－	1	－	3	5	38	11	7	2	3	－	11	12	1

ピーク帰属	Al_1=Al_2O_3, Al_2O_3	Si_1=SiO_2	B_1=B_2O_3
	Cl_1=Cl^-	Cl_2=Cl^-	Cl_3=C-Cl
	C_1=C-R	C_2=C-OR, C-Cl	C_3=C-C-OR
	N_1=NR_3	N_2=NR_3	N_3=NR_2
	O_1=金属酸化物, C=O, C-O	O_2=C=O, C-O	F_1=C-F

Moreover, the chemical analysis was performed also to the contaminant sample scratched from the chamber wall 122 after O2-/SF6 dry cleaning. Binding energy and atomic percent are as being shown in Table 2. The surface of the chamber wall was about 65 degrees C, and cleaning plasma was generated from SF6 of flux 25sccm, and O2 of flux 250sccm in 800W and 200mtorr. It turned out that there is no effect in controlling generation of an aluminum fluoride (AlFx) kind although this cleaning process is very useful for removal of the contaminant of hydrocarbon. The analysis result of the data of Table 2 shows that aluminum fluoride (AlFx) of fixity and an aluminum acid fluoride (AlxOyFz) compound are formed, when fluoride content plasma cleaning gas is used in combination with oxygen. A process chamber can surface accumulate such a compound as a parasitic contaminant, and it may blockade the small hole of a gas distribution plate. Moreover, data has suggested that a fixity aluminum fluoride (AlFx) kind is generated, when fluoride content plasma cleaning gas is used as independent halogen cleaning gas.

[0038]

[Table 2]

高分解能ＥＳＣＡデータ：結合エネルギー、原子百分率及びピーク帰属
（結合エネルギーは284.6eVでの-(ＣＨ$_2$)$_n$-信号の結合エネルギーに対応
原子百分率は高分解能データから算出
ピーク帰属は基準化合物の結合エネルギーに基づく）

サンプルの種類	Al$_1$	S$_1$	C$_1$	C$_2$	C$_3$	N$_1$	N$_2$	O$_1$	O$_2$	F$_1$	F$_2$
パターン化ウェハを６０℃でエッチング、その後、チャンバ壁のO$_2$／ＳＦ$_6$プラズマドライクリーニング											
結合エネルギー(eV)	76	170	285	286	289	400	402	533	534	485	687
原子百分率	19	0.8	14	4	3	1	1	5	3	11	35

ピーク帰属　Al$_1$＝ＡＬＦ$_x$　S$_1$＝ＳＯ$_x$　C$_1$＝C-R (R＝C, B)
C$_2$＝C-OR$_1$, C-R　C$_3$＝O=C-OR　N$_1$＝NR$_3$
N$_2$＝N-R$_4$'　O$_1$＝C=O　O$_2$＝C-O
F$_1$＝イオンF　F$_2$＝イオンF

The joint structure of aluminum has suggested that a part of aluminum content etching secondary output [at least] does not cause a complicated organic metal reaction with an organic matter kind during etching. Since the dipole moment of an aluminium chloride molecule and many organic matter molecules is large (based on electronic uneven distribution), a possibility that an aluminium chloride molecule will be combined with an organic matter kind by Van der Waals force or the dipole interaction is high. Then, in order to remove an aluminum content contaminant from the surface of a process chamber, it is necessary to contact an aluminium chloride / organic matter kind compound to "the reacting species (reactive species)" which can make Van der Waals force or a dipole interaction lose. According to this invention, one of such "the reacting species" is the inorganic gas mixture thing of fluoride content gas and chlorine content gas.

[0039] The quantity of the mineral salt matter content "reacting species" gas accompanied by fluoride content gas which is the gas mixture thing of this invention used in order to remove a contaminant from the surface of a process chamber is very important for obtaining a very good cleaning result.

[0040] for example, in order to decompose in reaction the covalent bond on the aluminum content compound which forms a contaminant and to destroy It is desirable to have sufficient reacting-species chlorine content inorganic matter gas to control generation of the fixity aluminum content compound with which aluminum fluoride, an aluminum acid fluoride kind, or others may be formed again in order to make associative strength lose. Similarly it is important that the validity of fluoride content cleaning gas is not reduced. It was found out that quick contaminant removal is dependent on the capacity concentration of the fluoride content gas in all the gas mixture things being more than at least 50% or it. In relation to this, chlorine content gas should exist with 10% - about 50% of least amount to the volume of all the fluoride / gaseous chlorine mixture of this invention.

[0041]

[A working example 2] In development of the dry-cleaning process improved by this invention of the aluminum etching chamber What evaluated three kinds of dry-cleaning plasma, namely, uses the chemical species based on oxygen, the thing which uses the chemical species based on fluoride, and the chemical species based on chlorine are used. For example, it is the cleaning plasma containing O2, SF6, O2/CF4, O2/N2, BCl3/Cl2, and SF6/Cl2. From a certain place in a process chamber, although the pollution sediment was removed, as a result of being obtained in the chemical species based on oxygen-fluoride using the chemical species based on the combined fluoride with the chemical species based on chlorine, it was not moderate.
[0042] A mixture with dry-cleaning plasma generating gas of this invention suitable for this example, The technology used in order to choose process chamber pressure and the source of RF electric power for attaining improvement dry cleaning of an etching plasma chamber is indicated (a fixed operation wall temperature is about 65 degrees C, and is maintained). In order to adjust a chamber, it is the work piece which consists of solid silicon covered in the aluminum layer, and the work piece which laminated the patternized photoresist which consists of 1400 to Shipley33 photoresist further is offered. Glow discharge plasma environment is made using BCl3 and Cl2 which are passed by about 50 sccm(s), respectively, and N2 gas. Power supply is from 500 to 800, process chamber pressure is the range of about 200 to 600mm Thor, operation work piece temperature is about 80 degrees C, and chamber wall temperature is maintained by 65 degrees C. Electric power is supplied for 3 minutes and it is found out after it that the solid film of about 0.2 (2000A) micro meter has covered to the whole chamber.
[0043] The experiment was conducted using dry etching cleaning of this covered chamber using prescription mentioned above. Although the most effective prescription is SF6/Cl2 mixture and SF6 etch hydrocarbon at a speed later than oxygen As a whole, very, or the very effective thing was found out in decreasing the quantity of the polymer within the chamber which is not. [aluminum acid fluoride (white powder) formation]
[0044] Furthermore, although there were O2/H2O/CF4 or SF6 the very thing and O2/CH3OH/CF4, or SF6 in other studied dry-cleaning chemical-species kinds, these were not effective for control or removal of aluminum acid fluoride (white powder) formation. Aluminum acid fluoride was generated in all the prescription containing oxygen. Although dry-cleaning prescription like O2/CF4 used ordinarily is effective for removing an organic compound, it is not suitable for sanctification of the aluminum etching chamber in polymer form with existence of aluminum. Although an organic substance is also removed with these dry-cleaning chemical species, the AlxOyF formation by existence of oxygen and fluoride is unavoidable. As emphasized in the top, this white powder can curve, causes the problem of the very thing and particle contamination, and blocks the hole of a gas supply plate. SF6/Cl2 were the most effective for removal of hydrocarbon, without affecting the conditions of a chamber greatly.

[0045] The lower table 3 shows the classification of the ingredient of the polymer covering thing which remains on the chamber after dry cleaning. Although the amount of fluoride in the polymer after SF6/Cl2 dry cleaning is the same as the thing after SF6 / O2 dry cleaning, that oxygen does not exist prevents formation of an aluminum acid fluoride (white powder) reaction product. Furthermore, SF6/Cl2 dry cleaning decreased the particle spike, and it was found out that it is uninfluential to an etching rate or homogeneity. Moreover, the process conditions of others [dry cleaning] did not affect a parameter, either.

[0046]

[Table 3]

ドライクリーニング後の重合体の化学組成
（ＥＳＣＡ分析，原子百分率）

	NO ドライクリーニング	O_2/CF_4 ドライクリーニング	O_2/SF_6 ドライクリーニング	$O_2/CF_4/CH_3OH$ ドライクリーニング	SF_6/Cl_2 ドライクリーニング
炭　素	56	36	23	36	33
窒　素	5	9	8	9	7
酸　素	23	26	27	28	25
アルミニウム	7	5	10	6	12
フッ素	1	0.2	16	1.3	18
塩　素	8	16	11	15	7

Other experiments were conducted using SF6 / Cl2 cleaning gas mixture thing of this invention with the etching chamber which has the design structure of drawing 1 . As the upper example showed, the gas from aluminum etching process prescription was used for the chamber, and it was covered with the sediment from the wafer with which the photoresist was applied. The frequency of dry cleaning between the etched wafers was between about 25 to 50 wafers. The flow velocities of SF6 of cleaning prescription were 85sccm, and the flow velocity of Cl2 was 10sccm. The chamber was operated at 100mm Thor, 200W, and 0 gauss, and it was for 60 seconds to 6 minutes at dry-cleaning processing. These experiments were conducted using 400 wafers.

[0047] These experiments show that this SF6/Cl2 cleaning gas prescription offered in that of the plasma environment which does not have oxygen substantially does not affect etching quality.

[0048] Furthermore, it was found out that the rate (the number of average wafers by which a process is carried out between wet sanctification) of an average pure wafer (mean wafer between clean (MWBC)) increases using this gas mixture thing in dry cleaning from 10 by 20%.

[0049] The source of plasma has combined the etching chamber of drawing 1 with the anode wall of cathode PEDISUTARU and a chamber in capacity, and PEDISUTARU and a chamber have one source of electric power. Drawing 2 shows the plasma etching chamber combined inductively. Since now performs the various processes of the semiconductor wafer including

metal and dielectric etching, the inductively-coupled-plasma reaction apparatus is used. In an etching process, [one advantageous point of inductively coupled plasma] High-density plasma is the minimum plasma DC bias for decreasing the damage to the integrated circuit equipment currently manufactured on work piece (wafer), and is offered in order to make a big etching rate possible. The power supply offered for this purpose to an antenna and DC bias offered to wafer PEDISUTARU are RF sources of supply controlled separately. Bias and separating the source of electric power make possible independent control of plasma concentration and ion NERUGI with the technology known well. In order to generate inductively coupled plasma, an antenna is a coil inductor which adjoins a chamber and the coil inductor is combined to the source of RF electric power. A coil inductor offers RF electric power, in order to maintain plasma. The composition of a coil inductor determines greatly space distribution of the plasma ion concentration within a reaction chamber.

[0050] With reference to drawing 2 , [a guidance joint RF plasma reaction apparatus] Are the grounded conductive cylindrical side wall 10 and the reaction chamber which has the dielectric ceiling 12, and [a reaction apparatus] They are wafer PEDISUTARU 14 which holds the semiconductor wafer 16 in the central part of a chamber, and; spiral inductor coil 40. Start a wafer or near the top plane of wafer PEDISUTARU, and the surroundings of the upper part of a chamber are surrounded. And it has what is prolonged upwards from there in the direction of the top part of a chamber, the source 22 of; process gas and the gas stream entrance 24 which introduces process gas into a chamber,; vacuum pump, and a chamber pressure control throttle. The coil inductor 40 is driven through the usual active RF matching network by the source of plasma electric power of the RF generator 28, and, as for the volume part of the top part of the coil inductor 40, the volume part of the bottom is grounded "hotly." Wafer PEDISUTARU 14 has what is the internal flare portion 32 and was combined with the source of bias RF electric power, or the generator 34, and has the external grounding conductor 36 (insulated from the internal conduction part 32). The conduction grounding RF shield 20 encloses the coil inductor 18.

[0051] A generation's newer inductively-coupled-plasma reaction apparatus gives an etching rate higher than the thing of the old model to precede. Therefore, pollution deposition speed also increases and it becomes earlier than a particle generating start. So, since these process stop that are the operation stops for the main wet cleaning more in the case of an efficient chamber or an etch apparatus rather than quick [depend and] becomes with a more expensive thing, its necessity for the in-between cleaning technology carried out in advance of the main wet cleaning is large. [the largest source of accumulation of the pollution particle in these pieces of equipment (it was shown in drawing 2 like)] It is the process kit including the upper part, internal Clun pulling 15 (not used when the electrostatic zipper is prepared) and focal ring 13, and internal PEDISUTARU cover (not shown) of a dome (ceiling). Application of

dry-cleaning etching of the inorganic halogenation gas mixture thing of this invention is for increasing MWBC of these reaction apparatus greatly in order to clean a process kit. [usually, the necessity of opening a chamber for wet cleaning for the defect by superfluous particle accumulation] It is caused by being based on the peeling omission of the KUREKU-like thing from the accumulation thing and the Clun pulling 15, or the focal ring equipment 13 from the dome of a chamber, or the internal surface of a wall.

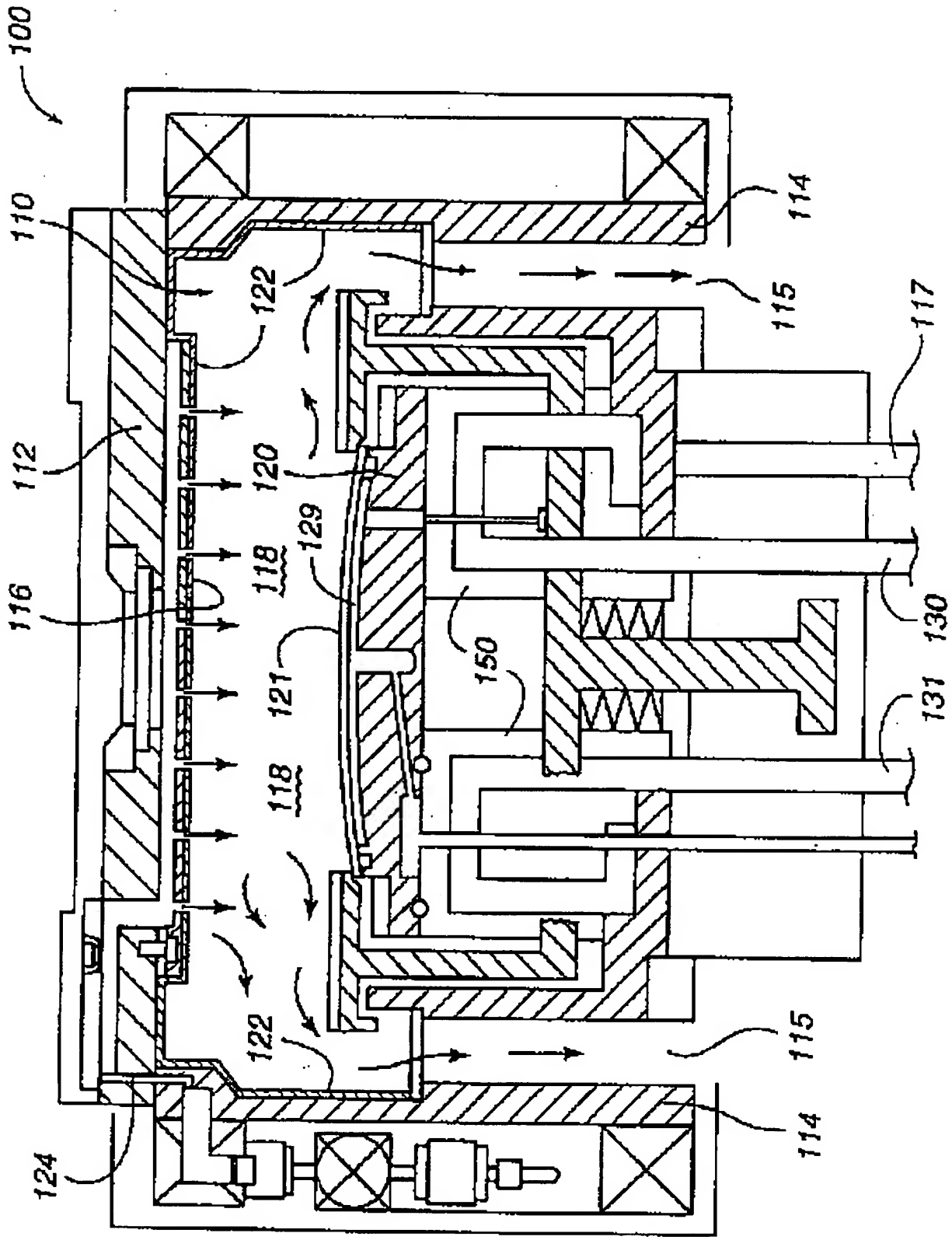
[0052] The experiment went with the inductively-coupled-plasma chamber using pure chlorine and various SF6/Cl2 cleaning gas prescription. SF6/Cl2 prescription is the sccm ratios 30/140, 60/110, 90/80, and 150/20, and was examined on condition of the 170sccm fixed total flow. Although dry cleaning in pure gaseous chlorine was found [removing some of accumulation things on the dome of a chamber] out, if the quantity of SF6 is added, removal of the accumulation thing will improve dramatically, and it is 150/20SF6/Cl2. Gas prescription removed the accumulation thing on a dome completely. Decreasing, if the thickness of the sediment which remained on the end chamber wall of a dome the dome top raises the ratio of SF6 was found out.

[0053] Quantitatively, an increase of the quantity of SF6 under SF6/Cl2 cleaning gas prescription will clean the internal surface of a dome dramatically.

[0054] The halogenation gas mixture thing of this invention is dry-cleaning technology, and the upper experimental data prevents the residual substance more effectively accumulated within a plasma process chamber, and there is less necessity for cleaning and it shows that it is what brings about the result whose operation is enabled more effectively.

[0055] For a person skilled in the art, it is clear for various modes to be possible within the limits of this invention so that it may be indicated to this invention. For example, drawing 1 and the chamber composition of 2 are illustration. Effective cleaning is brought about when other plasma equipment uses dry-cleaning prescription of this invention similarly.

[Translation done.]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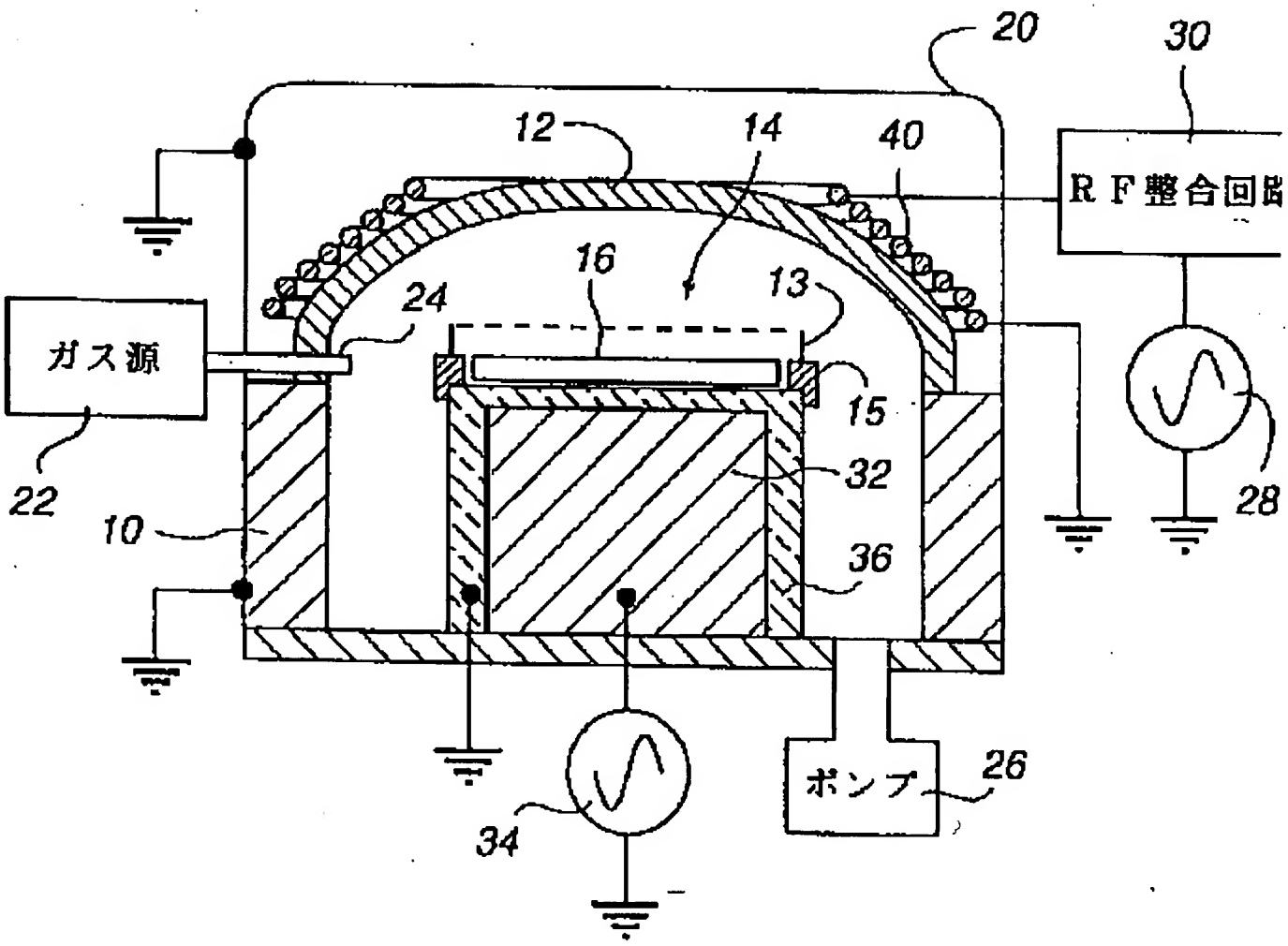
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